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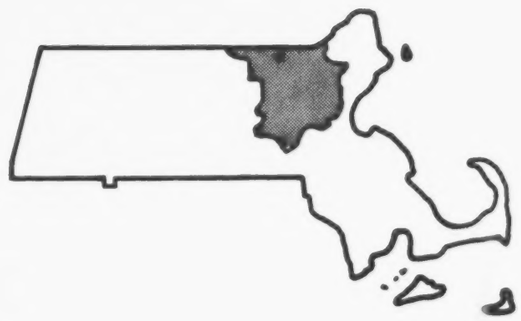
FLOOD INSURANCE STUDY

TOWN OF PEPPERELL, MASSACHUSETTS
MIDDLESEX COUNTY



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JANUARY 2, 1981

federal emergency management agency
federal insurance administration

COMMUNITY NUMBER - 250210

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PUBLISHED SEPARATELY:

Flood Insurance Rate Map Index

Flood Insurance Rate Map

FLOOD INSURANCE STUDY
TOWN OF PEPPERELL, MASSACHUSETTS

1.0 INTRODUCTION

1.1 Purpose of Study

The purpose of this Flood Insurance Study is to investigate the existence and severity of flood hazards in the Town of Pepperell, Middlesex County, Massachusetts, and to aid in the administration of the National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973. Initial use of this information will be to convert Pepperell to the regular program of flood insurance by the Federal Insurance Administration (FIA). Further use of the information will be made by local and regional planners in their efforts to promote sound land use and flood plain development.

1.2 Coordination

The initial Consultation and Coordination Officer's (CCO) meeting was held on April 30, 1976 and was attended by representatives of the Town of Pepperell, the FIA, and Howard, Needles, Tammen & Bergendoff (the study contractor). The purpose of this meeting was to discuss the nature and purpose of the study, the scope and the limits of the work, and flood information currently available concerning the community.

Upon initiation of the study, a legal notice was placed in the Times Free Press one day a week for three consecutive weeks, beginning July 29, 1976, to notify all interested persons so that they could submit any relevant facts and technical data concerning local flood hazards.

During the course of the study, a search for basic data was made at all levels of government, including the Town Board of Selectmen, the Conservation Commission, the Planning Commission, the Assessors Office, the Highway Department, the Historical Society and the Public Library. In addition, the Pepperell Paper Company, operators of a dam on the Nashua River, the Massachusetts Department of Natural Resources, the New England Interstate Water Pollution Control Commission, and the U. S. Geological Survey (USGS), were also contacted.

An intermediate CCO meeting was held on November 28, 1977 to discuss the progress of the study.

On December 12, 1979, results of the study were reviewed at the final CCO meeting which was attended by representatives of the Town of Pepperell, the FIA, and the study contractor.

1.3 Authority and Acknowledgements

The source of authority for this Flood Insurance Study is the National Flood Insurance Act of 1968, as amended.

The hydrologic and hydraulic analyses for this study were prepared by Howard, Needles, Tammen & Bergendoff, for the Federal Insurance Administration, under Contract No. H-4004. Raytheon Autometrics, under subcontract to the study contractor, provided supplemental topographic mapping for areas along the Nashua River, the Nissitissit River, and Reedy Meadow Brook. Schofield Brothers, Incorporated, also under subcontract to the study contractor, provided field survey data and aerial photogrammetric mapping along portions of the Nissitissit River and Reedy Meadow Brook, the aerial photogrammetric mapping being provided by Teledyne Geotronics. This work, which was completed in January 1978, covered all significant flooding sources in the Town of Pepperell.

2.0 AREA STUDIED

2.1 Scope of Study

This Flood Insurance Study covers the incorporated area of the Town of Pepperell, Massachusetts. The area of study is shown on the Vicinity Map (Figure 1).

Floods caused by overflow of the Nashua River and portions of the Nissitissit River and Reedy Meadow Brook were studied by detailed methods. The areas studied by detailed methods were selected with priority given to all known flood hazard areas, areas of projected development and proposed construction for the next five years, through January 1983.

Portions of the Nissitissit River, Steward Brook, Gulf Brook, Sucker Brook, Greens Brook, Bancroft Brook, Robinson Brook, Mine Brook, Varnum Brook, and numerous other unnamed tributaries were studied by approximate methods.

Approximate methods of analysis were used to study those areas having low development potential and/or minimal flood hazards as identified at the initiation of the study. The scope and methods of study were proposed to and agreed upon by the FIA.

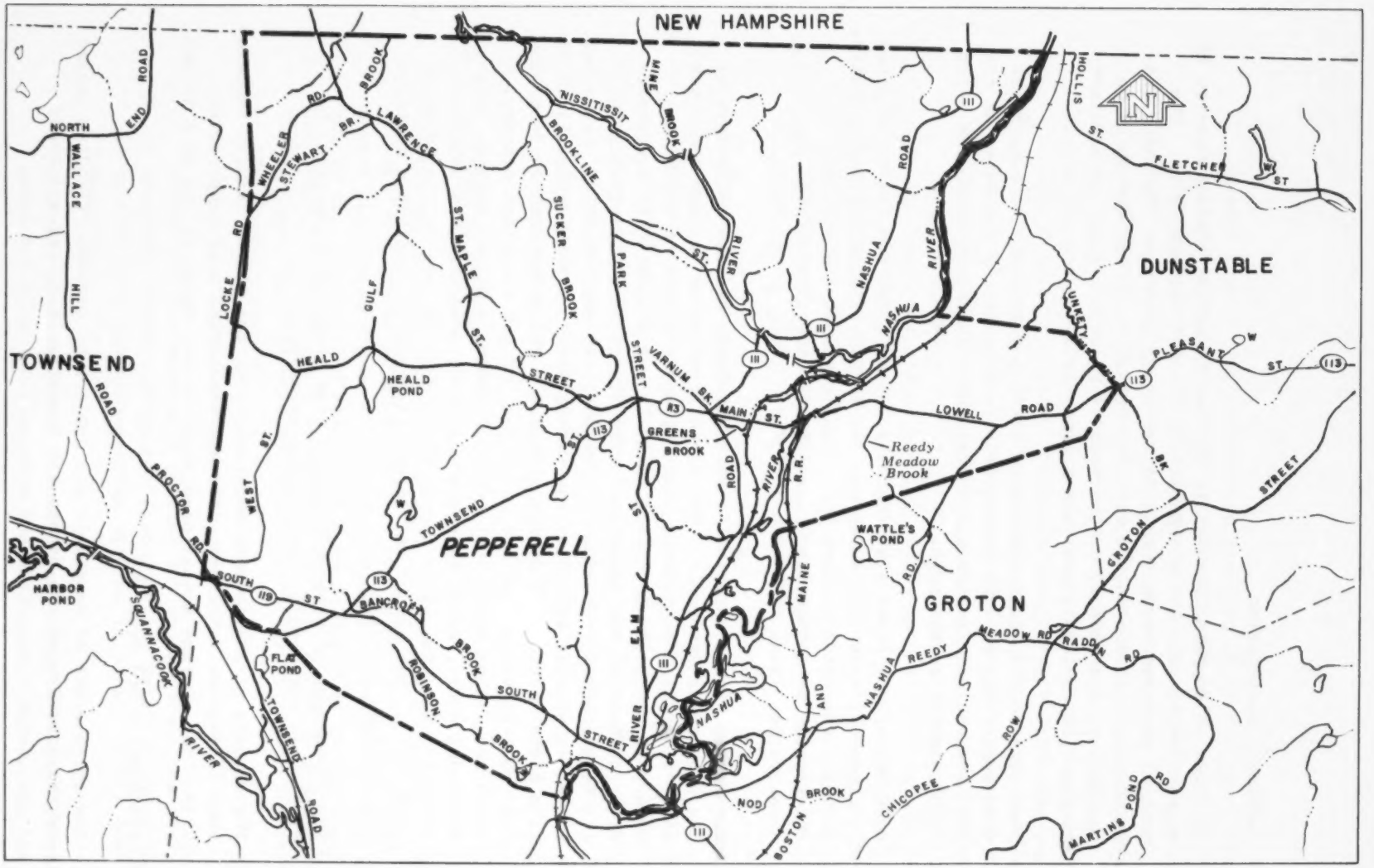

FIGURE 1

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF PEPPERELL, MA
(MIDDLESEX CO.)

APPROXIMATE SCALE
1 0 1 2 3 MILES

VICINITY MAP

2.2 Community Description

The Town of Pepperell, which is located in northern Massachusetts 35 miles from Boston, has a population of 5,887 (Reference 1). The town is bordered by Dunstable on the east, Groton on the south and southeast, Townsend on the west and the State of New Hampshire on the north. The economy of the town is based primarily on manufacturing with wholesale and retail trade as the secondary source.

Since the town's establishment in 1753, residential and commercial development has focused around Pepperell Center on the banks of the Nashua River with residential development spreading along the major thoroughfares in the town.

Portions of the flood plain for the Nashua River and its tributaries in Pepperell have been developed both residentially and commercially. However, recently the town has sought to limit such flood plain development by designating parts of the undeveloped flood plain as conservation land.

The Nashua River, Pepperell's main waterway, has its headwaters at the Wachusetts Reservoir. The river flows north through Lancaster where it forms a confluence with the North Branch of the Nashua River; it continues northward until it outlets into the Merrimack River at Nashua, New Hampshire. The Nissitissit River, which has its headwaters in Potanopa Pond, Brookline, New Hampshire, traverses through Pepperell and joins the Nashua River in East Pepperell, 0.75 mile north of the Mill Street bridge. A 251 foot wide, 20 foot high dam, constructed during the early part of the twentieth century, spans the Nashua River just south of the Main Street bridge. The impounded water, known as Pepperell Pond, generates hydroelectric power and provides water supply for industrial use at the adjacent paper mill. The brooks and rivers in Pepperell exhibit a rectangular drainage pattern.

The topography of Pepperell varies from steep hilly terrain, to flat areas surrounding the various waterways.

The climate of the town is moderate, with the normal January temperature 26 degrees Fahrenheit (°F) and the normal July temperature 72°F. The average annual precipitation for Pepperell is 42.6 inches.

2.3 Principal Flood Problems

Low-lying areas of Pepperell are subject to periodic flooding caused by the overflow of the Nashua and Nissitissit Rivers and Reedy

Meadow Brook. The most severe flooding in recent years, especially on the Nashua River, occurred during March 1936. This flood resulted from a succession of meteorological events. Above average snowfall with accompanying cold weather and frozen ground, followed by mild temperatures and repeated days of rain in the early spring, saturated the ground causing intensive run-off and massive flooding. Roads were awash, bridges collapsed, and factories and homes were inundated. Like many of the great New England storms, this one was a result of a warm moisture laden tropical air mass, moving from the West Indies to the Florida coast, which was forced northeasterly over the Atlantic Ocean by high pressure areas situated along the mid-Atlantic coast. The peak flow during the March 1936 flood as recorded by the USGS East Pepperell gaging station on the Nashua River was 20,900 cubic feet per second. The 1936 record event is estimated to have a recurrence frequency of 0.3 percent in any given year. Repeated structural damage has occurred in the Nashua River flood plain as a result of the floods of May 1850, December 1878, July 1897, February 1900, March 1900, March 1936 and March 1968.

2.4 Flood Protection Measures

There are no flood protection works on the rivers and streams in the Town of Pepperell. The two dams which do exist, the Pepperell Pond Dam on the Nashua River and a dam on the Nissitissit River, offer no flood protection. However, the town has sought to limit flood plain development by designating parts of the undeveloped flood plain as conservation land, a flood control measure in itself.

3.0 ENGINEERING METHODS

For the flooding sources studied in detail in the community, standard hydrologic and hydraulic study methods were used to determine the flood hazard data required for this study. Floods having recurrence intervals of 10, 50, 100, and 500 years have been selected as having special significance for flood plain management and for insurance premium rates. The analyses reported here reflect current conditions in the watersheds of the flooding sources.

3.1 Hydrologic Analyses

Hydrologic analyses were carried out to establish the peak discharge-frequency relationships for floods of the selected recurrence intervals for the flooding sources studied in detail in the Town of Pepperell.

A gaging station on the Nashua River, located in East Pepperell about 0.8 mile upstream from the Nissitissit River, was the

principal source of the data utilized for defining discharge-frequency relationships for this river (References 2 and 3). This gage has been in operation since 1936. Values for the 10-, 50-, 100- and 500-year peak discharges at the gage were obtained from a log-Pearson Type III distribution of annual peak flow data. In order to define discharge-frequency relationships for the Nahsua River at sections upstream and downstream of the gaging station, a method of analysis as defined by the Soil Conservation Service (SCS) was utilized (Reference 4). This method relates the discharge, in cubic feet per second per square mile, between any two points in the drainage basin by a ratio of the respective drainage areas.

To define discharge-frequency data for the Nissitissit River and Reedy Meadow Brook, regional equations as developed by Johnson and Tasker were utilized (Reference 5). These equations, which relate basin characteristics to stream flow, provided the method for which the 10-, 50- and 100-year peak discharges were obtained. The 500-year peak discharge was obtained graphically using the data obtained by the Johnson and Tasker method. Discharge-frequency data obtained as described above was compared with previously compiled data where such data was available and applicable.

A summary of drainage area-peak discharge relationships for the streams studied by detailed methods is shown in Table 1, "Summary of Discharges".

TABLE 1 - SUMMARY OF DISCHARGES

FLOODING SOURCE AND LOCATION	DRAINAGE AREA (sq. miles)	PEAK DISCHARGES (cfs) 10-YEAR	50-YEAR	100-YEAR	500-YEAR
NASHUA RIVER					
Massachusetts-New Hampshire state line	396	8,300	14,300	17,800	28,300
At confluence of the Nissitissit River	325	7,055	11,945	14,651	22,829
NISSITISSIT RIVER					
At confluence with the Nashua River	59.76	1,497	2,642	3,294	5,000
REEDY MEADOW BROOK					
At confluence with the Nashua River	2.72	124	190	220	299

3.2 Hydraulic Analyses

Analyses of the hydraulic characteristics of the flooding sources studied in detail in the community were carried out to provide estimates of the elevations of floods of the selected recurrence intervals along each of these flooding sources.

Water-surface profiles for the streams studied by detailed methods were computed through the use of the U. S. Army Corps of Engineers (COE) HEC-2 step-backwater computer program (References 6 and 7). Starting water-surface elevations for the Nashua River were determined by a series of backwater computations downstream of Pepperell. For the Nissitissit River and Reedy Meadow Brook starting water-surface elevations were determined at their confluence with the Nashua River. Backwater effects at confluences with larger stream systems are reflected on the Flood Profiles (Exhibit 1).

Cross sections for the backwater analyses of the Nashua River, the Nissitissit River, and Reedy Meadow Brook were obtained from photogrammetric mapping. The below-water sections were obtained by field measurements and from previously compiled survey information. All bridges, culverts, and dams were surveyed to obtain elevation data and structural geometry in order to compute the significant backwater effects of these structures.

Roughness factors (Manning's "n") for these computations were estimated on the basis of field inspection and through the analysis of aerial photographs. For the Nashua River, roughness coefficients were verified by the HEC-2 computer program using historic flood data (References 8 through 12). The range of roughness coefficients for the chnnel and overbank areas for the Nashua River is 0.03 and 0.06 to 0.07, respectively, for the Nissitissit River 0.04 and 0.06 to 0.09, respectively, and for Reedy Meadow Brook 0.04 and 0.05 to 0.07, respectively.

Flood profiles were drawn showing computed water-surface elevations to an accuracy of 0.5 foot for floods of the selected recurrence intervals. Locations of selected cross sections used in the hydraulic analyses are shown on the Flood Profiles (Exhibit 1). For stream segments for which a floodway is computed (Section 4.2), selected cross-section locations are also shown on the Flood Boundary and Floodway Map (Exhibit 3).

All elevations are referenced to the National Geodetic Vertical Datum of 1929 (NGVD), formerly referred to as Sea Level Datum of 1929. The locations of the elevation reference marks used in the study are shown on the maps.

The extent of flooding along approximate study streams, streams which flow through undeveloped areas of the town or streams with small drainage areas, was delineated using the Flood Hazard Boundary Maps for Pepperell (Reference 13).

The hydraulic analyses for this study are based only on the effects of unobstructed flow. The flood elevations as shown on the profiles, are thus considered valid only if hydraulic structures in general remain unobstructed and do not fail.

4.0 FLOOD PLAIN MANAGEMENT APPLICATIONS

A prime purpose of the National Flood Insurance Program is to encourage state and local governments to adopt sound flood plain management programs. Each Flood Insurance Study, therefore, includes a flood boundary map designed to assist communities in developing sound flood plain management measures.

4.1 Flood Boundaries

In order to provide a national standard without regional discrimination, the 100-year flood has been adopted by the FIA as the base flood for purposes of flood plain management measures. The 500-year flood is employed to indicate additional areas of flood risk in the community. For each stream studied in detail, the boundaries of the 100- and 500-year floods have been delineated using the flood elevations determined at each cross section; between cross sections, the boundaries were interpolated using topographic maps at a scale of 1:2,400 with contour intervals of 2 and 4 feet, respectively (References 14 and 15). In cases where the 100- and 500-year flood boundaries are close together, only the 100-year boundary has been shown.

The methodology for the delineation of approximate flood boundaries is described in Section 3.2.

The boundaries of the 100- and 500-year floods are shown on the Flood Boundary and Floodway Map (Exhibit 3). Small areas within the flood boundaries may lie above the flood elevations, and therefore, may not be subject to flooding. Owing to limitations of the map scale and lack of detailed topographic data, such areas are not shown.

4.2 Floodways

Encroachment on flood plains, such as artificial fill, reduces the flood-carrying capacity, increases flood heights of streams, and

increases flood hazards in areas beyond the encroachment itself. One aspect of flood plain management involves balancing the economic gain from flood plain development against the resulting increase in flood hazard. For purposes of the Flood Insurance Program, the concept of a floodway is used as a tool to assist local communities in this aspect of flood plain management. Under this concept, the area of the 100-year flood is divided into a floodway and a floodway fringe. The floodway is the channel of a stream plus any adjacent flood plain areas that must be kept free of encroachment in order that the 100-year flood may be carried without substantial increases in flood heights. Minimum standards of the FIA limit such increases in flood heights to 1.0 foot, provided that hazardous velocities are not produced. The floodways in this report are presented to local agencies as minimum standards that can be adopted or that can be used as a basis for additional studies.

The floodways presented in this study were computed on the basis of equal conveyance reduction from each side of the flood plains. The results of these computations are tabulated at selected cross sections for each stream segment for which a floodway is computed (Table 2).

As shown on the Flood Boundary and Floodway Map (Exhibit 3), the floodway widths were determined at cross sections; between cross sections, the boundaries were interpolated. In cases where the boundaries of the floodway and the 100-year flood are either close together or collinear, only the floodway boundary has been shown.

The area between the floodway and the boundary of the 100-year flood is termed the floodway fringe. The floodway fringe thus encompasses the portion of the flood plain that could be completely obstructed without increasing the water-surface elevation of the 100-year flood more than 1.0 foot at any point. Typical relationships between the floodway and the floodway fringe and their significance to flood plain development are shown in Figure 2.

Near the mouths of streams studied in detail, floodway computations are made without regard to flood elevations on the receiving water body. Therefore, "With Floodway" elevations presented in Table 2 for certain downstream cross sections of the Nissitissit River and Reedy Meadow Brook are lower than the regulatory flood elevations in that area, which must take into account the 100-year flooding due to backwater from other sources.

Portions of the Nashua River floodway are located outside the corporate limits of Pepperell.

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE (FT.)
Nashua River							
A	0.13	369[2]	4,915	3.6	177.9	176.9	1.0
B	0.23	918[2]	8,299	2.1	178.2	177.2	1.0
C	0.39	721[2]	5,104	3.5	178.2	177.2	1.0
D	0.56	323[2]	3,709	4.8	178.5	177.5	1.0
E	0.72	325[2]	3,672	4.8	178.9	177.9	1.0
F	0.74	230[2]	3,588	5.0	179.0	178.0	1.0
G	0.90	210[2]	3,460	5.1	179.2	178.2	1.0
H	1.09	175[2]	2,790	6.4	179.4	178.4	1.0
I	1.23	175[2]	2,820	6.3	179.8	178.9	0.9
J	1.33	125[2]	2,178	8.2	179.8	178.9	0.9
K	1.43	272[2]	2,984	6.0	180.5	179.6	0.9
L	1.73	157[2]	2,702	6.6	181.2	180.3	0.9
M	1.94	308[2]	3,831	4.6	181.9	181.1	0.8
N	2.18	222	3,246	5.5	182.3	181.5	0.8
O	2.45	663	4,446	4.0	183.0	182.2	0.8
P	2.57	618	5,456	3.3	183.2	182.4	0.8
Q	2.75	1,019	10,614	1.4	183.7	182.9	0.8
R	2.96	125	1,962	7.5	183.7	182.9	0.8
S	3.05	219	3,265	4.5	184.1	183.3	0.8

[1]Miles above corporate limits
[2]This width extends beyond the corporate limits

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF PEPPERELL, MA
(MIDDLESEX CO.)

FLOODWAY DATA

NASHUA RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE (FT.)
Nashua River (continued)							
T	3.10	365	3,529	4.2	184.3	183.5	0.8
U	3.18	240	3,691	4.0	184.6	183.7	0.9
V	3.24	167	2,388	6.1	184.6	183.7	0.9
W	3.39	200	2,676	5.5	185.0	184.2	0.8
X	3.51	267	4,561	3.2	185.5	184.7	0.8
Y	3.61	125	1,183	12.4	185.5	184.7	0.8
Z	3.63	93	900	16.3	185.5	184.7	0.8
AA	3.81	376	5,040	2.9	203.2	203.2	0.0
AB	4.05	252	3,053	4.8	203.3	203.3	0.0
AC	4.18	350	4,071	3.6	203.6	203.6	0.0
AD	4.33	545	6,560	2.2	203.8	203.8	0.0
AE	4.38	250	3,537	4.2	203.9	203.9	0.0
AF	4.57	1,590[2]	14,147	1.0	204.1	204.1	0.0
AG	4.83	411[2]	4,626	3.2	204.2	204.2	0.0
AH	4.92	2,224[2]	25,060	0.6	204.4	204.3	0.1
AI	5.16	2,185[2]	18,231	0.8	204.5	204.4	0.1
AJ	5.51	803[2]	6,200	2.4	204.5	204.4	0.1
AK	5.87	1,040[2]	6,248	2.4	204.9	204.7	0.2

[1]Miles above corporate limits
[2]This width extends beyond the corporate limits

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF PEPPERELL, MA
(MIDDLESEX CO.)

FLOODWAY DATA

NASHUA RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE	WIDTH (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE (FT.)
Nashua River (continued)							
AL	6.36[1]	1,590[3]	6,088	2.4	205.2	205.0	0.2
AM	7.02[1]	1,140[3]	6,440	2.3	205.9	205.6	0.3
AN	7.12[1]	775[3]	5,017	2.9	206.0	205.7	0.3
AO	7.23[1]	980[3]	6,003	2.4	206.4	205.9	0.5
AP	7.34[1]	1,117[3]	6,430	2.3	207.1	206.6	0.5
AQ	7.49[1]	595[3]	3,744	3.9	207.1	206.6	0.5
AR	7.63[1]	580[3]	3,847	3.8	207.4	206.9	0.5
Nissitissit River							
A	3,580[2]	145	922	3.6	182.5	181.5[4]	1.0
B	4,180[2]	123	814	4.0	183.3	182.4[4]	0.9
C	4,630[2]	70	494	6.7	184.0	183.1	0.9
D	4,810[2]	121	980	3.4	184.9	184.2	0.7
E	5,280[2]	242	1,091	3.0	185.2	184.6	0.6
F	6,050[2]	81	373	8.8	187.9	187.8	0.1
G	6,450[2]	90	472	7.0	191.8	191.8	0.0
H	6,600[2]	123	576	5.7	200.0	199.7	0.3

[1] Miles above corporate limits
[2] Feet above confluence with the Nashua River
[3] This width extends beyond corporate limits
[4] Elevations computed without consideration of backwater effects from the Nashua River

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF PEPPERELL, MA
(MIDDLESEX CO.)

FLOODWAY DATA

NASHUA RIVER AND NISSITISSIT RIVER

FLOODING SOURCE		FLOODWAY			BASE FLOOD WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE (FT.)
Nissitissit River (continued)							
I	6,850	240	1,003	3.3	200.8	200.4	0.4
J	8,100	88	775	4.2	201.9	201.5	0.4
K	9,600	123	765	4.3	203.5	203.1	0.4
L	11,070	74	568	5.8	205.5	205.3	0.2
M	12,700	103	797	4.1	207.8	207.5	0.3
N	14,270	95	653	5.0	209.8	209.5	0.3
O	14,520	65	627	5.2	210.2	210.0	0.2
P	16,650	140	1,330	2.5	211.4	211.0	0.4
Reedy Meadow Brook							
A	1,130	136	652	0.3	180.9	180.9[2]	0.0
B	1,330	93	605	0.4	183.5	182.6[2]	0.9
C	1,840	119	772	0.3	183.5	182.6[2]	0.9
D	2,440	64	242	0.9	183.5	182.6[2]	0.9
E	2,730	46	334	0.7	188.2	187.3	0.9
F	2,963	63	357	0.6	188.3	187.5	0.8

[1] Feet above confluence with the Nashua River
[2] Elevations computed without consideration of backwater effects from the Nashua River

TABLE 2

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF PEPPERELL, MA
(MIDDLESEX CO.)

FLOODWAY DATA

NISSITISSIT RIVER AND REEDY MEADOW BROOK

FLOODING SOURCE		FLOODWAY			WATER SURFACE ELEVATION		
CROSS SECTION	DISTANCE[1]	WIDTH (FT.)	SECTION AREA (SQ. FT.)	MEAN VELOCITY (F.P.S.)	WITH FLOODWAY (NGVD)	WITHOUT FLOODWAY (NGVD)	DIFFERENCE (FT.)
Reedy Meadow Brook (continued)							
G	3,140	148	1,176	0.2	188.7	187.8	0.9
H	3,890	224	1,344	0.2	188.7	187.8	0.9
I	4,680	194	729	0.3	188.7	187.8	0.9
J	5,720	35	51	4.3	192.9	192.8	0.1
K	6,720	52	64	3.4	200.7	200.3	0.4

[1]Feet above confluence with the Nashua River

FLOODWAY DATA

REEDY MEADOW BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF PEPPERELL, MA
(MIDDLESEX CO.)

TABLE 2

100 YEAR FLOOD PLAIN
FLOODWAY FRINGE
FLOODWAY
FLOODWAY FRINGE
STREAM CHANNEL
FLOOD ELEVATION WHEN CONFINED WITHIN FLOODWAY
ENCROACHMENT
ENCROACHMENT
C
D
A
B
SURCHARGE*
AREA OF FLOOD PLAIN THAT COULD BE USED FOR DEVELOPMENT BY RAISING GROUND
FLOOD ELEVATION BEFORE ENCROACHMENT ON FLOOD PLAIN
LINE A - B IS THE FLOOD ELEVATION BEFORE ENCROACHMENT
LINE C - D IS THE FLOOD ELEVATION AFTER ENCROACHMENT
*SURCHARGE NOT TO EXCEED 1.0 FOOT (FIA REQUIREMENT) OR LESSER AMOUNT IF SPECIFIED BY STATE.

FLOODWAY SCHEMATIC

Figure 2

5.0 INSURANCE APPLICATION

In order to establish actuarial insurance rates, the FIA has developed a process to transform the data from the engineering study into flood insurance criteria. This process includes the determination of reaches, Flood Hazard Factors (FHFs), and flood insurance zone designations for each flooding source affecting the Town of Pepperell.

5.1 Reach Determinations

Reaches are defined as lengths of watercourses having relatively the same flood hazard, based on the average weighted difference in water-surface elevations between the 10- and 100-year floods. This difference does not have a variation greater than that indicated in the following table for more than 20 percent of the reach.

Average Difference Between 10- and 100-Year Floods	Variation
Less than 2 feet	0.5 foot
2 to 7 feet	1.0 foot

The locations of the reaches determined for the flooding sources of the Town of Pepperell are shown on the Flood Profiles (Exhibit 1) and are summarized in the Flood Insurance Zone Data Table (Table 3).

5.2 Flood Hazard Factors

The FHF is the FIA device used to correlate flood information with insurance rate tables. Correlations between property damage from floods and their FHFs are used to set actuarial insurance premium rate tables based on FHFs from 005 to 200.

The FHF for a reach is the average weighted difference between the 10- and 100-year flood water-surface elevations expressed to the nearest 0.5 foot, and shown as a three-digit code. For example, if the difference between water-surface elevations of the 10- and 100-year floods is 0.7 foot, the FHF is 005; if the difference is 1.4 feet, the FHF is 015; if the difference is 5.0 feet, the FHF is 050. When the difference between the 10- and 100-year flood water-surface elevations is greater than 10.0 feet, accuracy for the FHF is to the nearest foot.

5.3 Flood Insurance Zones

After the determination of reaches and their respective FHFs, the entire incorporated area of the Town of Pepperell was divided into zones, each having a specific flood potential or hazard. Each zone was assigned one of the following flood insurance zone designations:

Zone A:	Special Flood Hazard Areas inundated by the 100-year flood, determined by approximate methods; no base flood elevations shown or FHFs determined.
Zones A1, A5, A6, A11:	Special Flood Hazard Areas inundated by the 100-year flood, determined by detailed methods; base flood elevations shown and zones subdivided according to FHF.

Zone B:	Areas between the Special Flood Hazard Area and the limits of the 500-year flood, including areas of the 500-year flood plain that are protected from the 100-year flood by dike, levee, or other water-control structure; also, areas subject to certain types of 100-year shallow flooding where depths are less than 1.0 foot; and areas subject to 100-year flooding from sources with drainage areas less than 1 square mile. Zone B is not subdivided.
Zone C:	Areas of minimal flooding.

Table 3, "Flood Insurance Zone Data," summarizes the flood elevation differences, FHFs, flood insurance zones, and base flood elevations for the flooding sources studied in detail in the community.

5.4 Flood Insurance Rate Map Description

The Flood Insurance Rate Map for the Town of Pepperell is, for insurance purposes, the principal result of the Flood Insurance Study. This map (published separately) contains the official delineation of flood insurance zones and base flood elevation lines. Base flood elevation lines show the location of the expected whole-foot water-surface elevations of the base (100-year) flood. This map is developed in accordance with the latest flood insurance map preparation guidelines published by the FIA.

6.0 OTHER STUDIES

In 1973, the Commonwealth of Massachusetts, Department of Natural Resources, Division of Water Resources published a series of maps delineating the area along the Nashua River, within Massachusetts, which was inundated by the flood of March 1936 (Reference 14).

Flood Insurance Studies which have been completed or are currently being conducted for adjoining towns were coordinated with the Flood Insurance Study for the Town of Pepperell. Those studies include the Flood Insurance Study for the Town of Hollis, New Hampshire, which was performed by Anderson-Nichols, and the Flood Insurance Studies for the Towns of Groton and Townsend, Massachusetts, which are being prepared by the study contractor (References 16, 17, and 18). No conflicts with those studies exist. No FIS information on the adjacent Town of Dunstable was available at the time of publication of this study.

The COE has studied flooding along the North Nashua River in the Cities of Leominster and Fitchburg, Massachusetts, and as a result has proposed

FLOOD INSURANCE ZONE DATA

NASHUA RIVER, NISSITISSIT RIVER, AND REEDY MEADOW BROOK

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF PEPPERELL, MA
(MIDDLESEX CO.)

TABLE 3

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND		FHF	ZONE	BASE FLOOD ELEVATION[3]
		10% (10 YR.)	2% (50 YR.)			
Nashua River						
Reach 1	02	-5.5	-1.7	055	A11	Varies
Reach 2	02,03,04	-2.8	-0.8	030	A6	Varies
Nissitissit River						
Reach 1	01,02	-2.4	-0.7	025	A5	Varies
Reedy Meadow Brook						
Reach 1	02,04	-0.5	-0.2	005	A1	Varies

FLOODING SOURCE	PANEL[1]	ELEVATION DIFFERENCE[2] BETWEEN 1.0% (100-YEAR) FLOOD AND		FHF	ZONE	BASE FLOOD ELEVATION[3]
		10% (10 YR.)	0.2% (500 YR.)			
Nashua River						
Reach 1	02	-5.5	+4.5	055	A11	Varies
Reach 2	02,03,04	-2.8	+1.9	030	A6	Varies
Nissitissit River						
Reach 1	01,02	-2.4	+1.5	025	A5	Varies
Reedy Meadow Brook						
Reach 1	02,04	-0.5	+0.4	005	A1	Varies

[1]FLOOD INSURANCE RATE MAP PANEL
[2]WEIGHTED AVERAGE
[3]ROUNDED TO THE NEAREST FOOT-SEE MAP

various upstream flood control measures, including the construction of channel improvements to the North Nashua River and flood control dams in Fitchburg and Leominster (Reference 19). Although these measures would have a modifying effect on the flooding of the Nashua River in Pepperell, except for the aforementioned channel improvements, they were not included in this study since the construction time table is beyond the criteria of this study.

This study is authoritative for purposes of the Flood Insurance Program and the data presented here either supersede or are compatible with previous determinations.

7.0 LOCATION OF DATA

Survey, hydrologic, hydraulic, and other pertinent data used in this study can be obtained by contacting the office of the Insurance and Mitigation Division of the Federal Emergency Management Agency, Regional Director, Region I Office, J. W. McCormack Post Office and Courthouse Building, Room 462, Boston, Massachusetts 02109.

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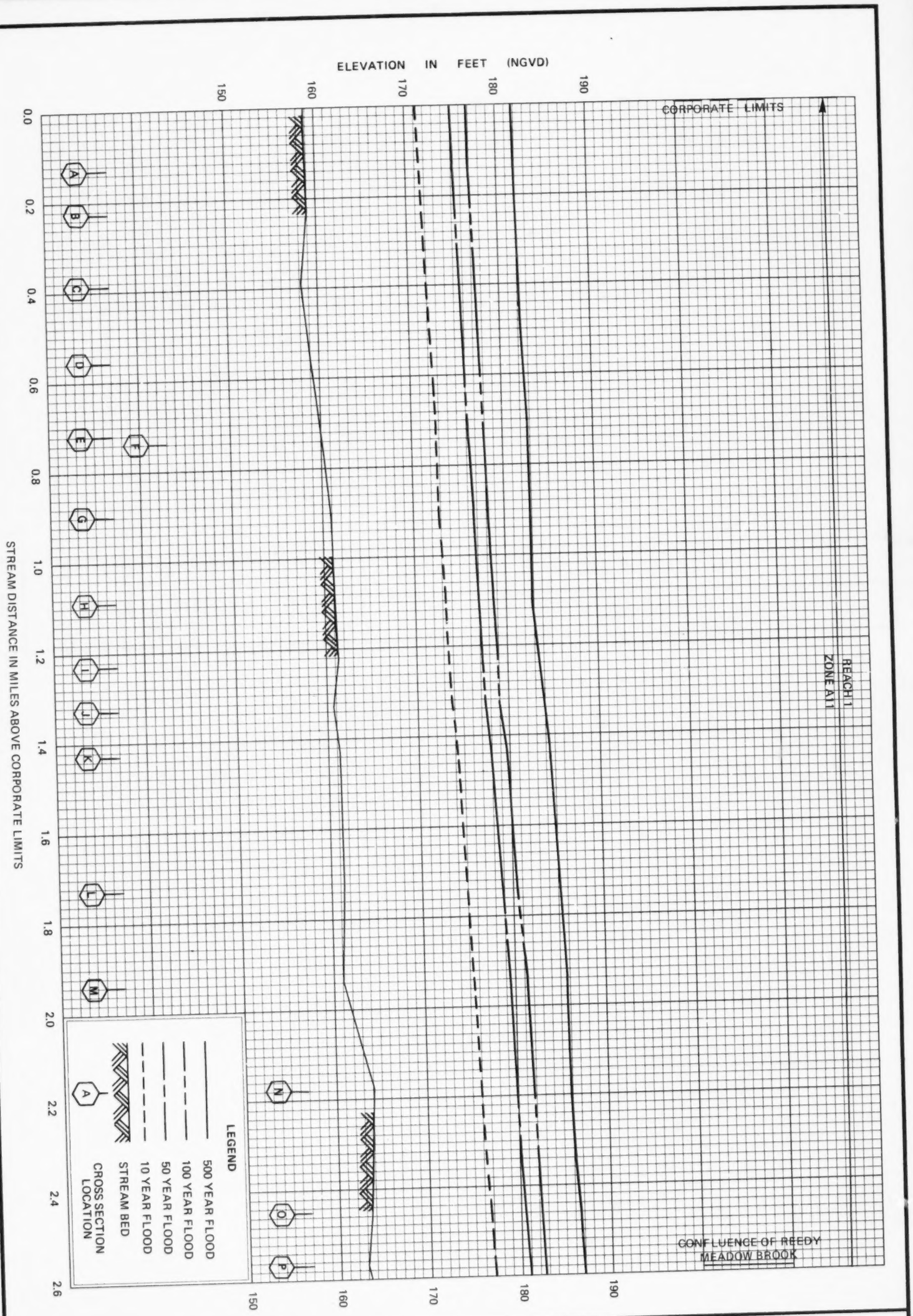

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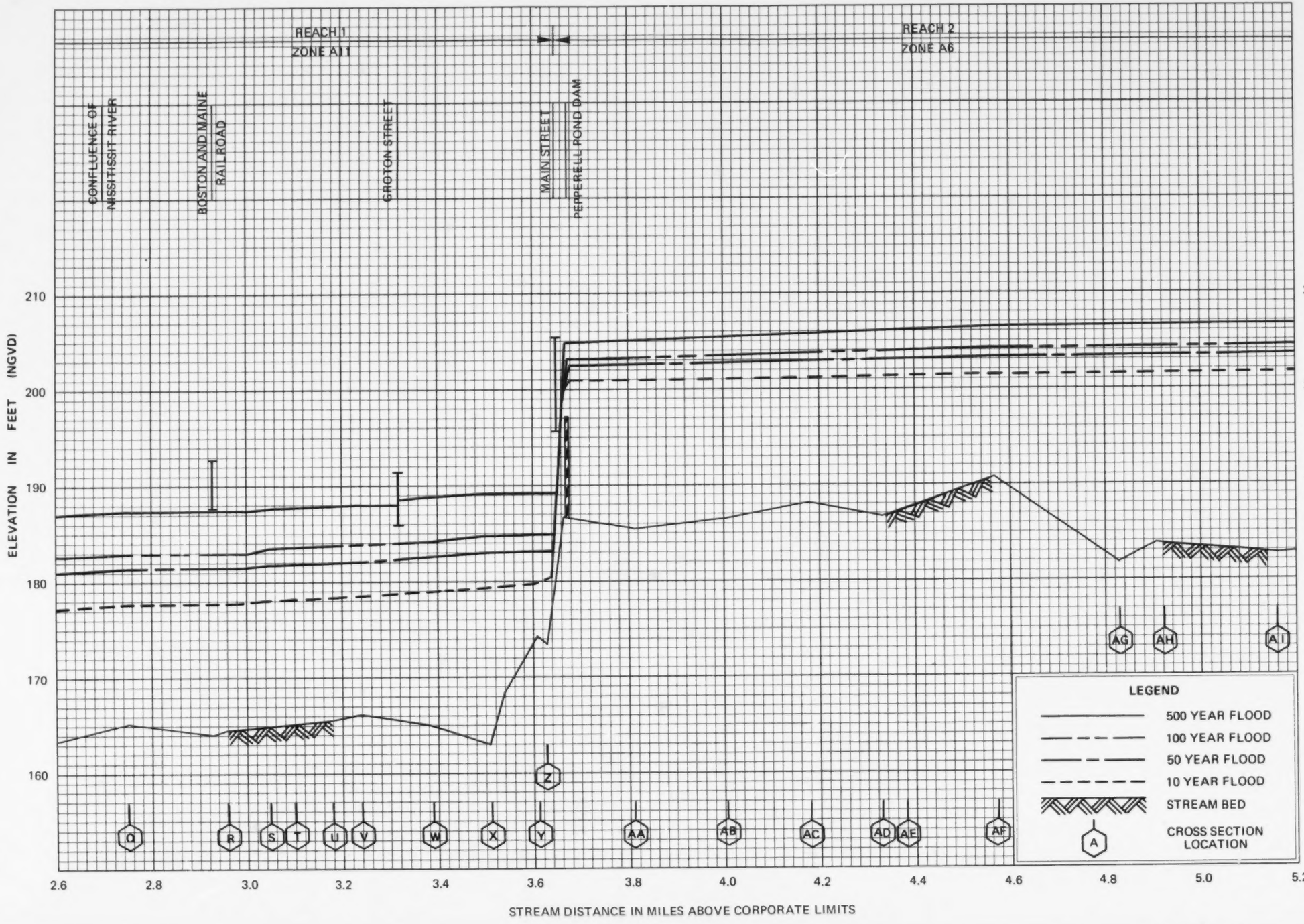
FLOOD PROFILES

NASHUA RIVER

01P



FLOOD PROFILES

NASHUA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF PEPPERELL, MA
(MIDDLESEX CO.)

02P

REACH 2
ZONE A6

MAIN STREET
STATE ROUTE 119

ELEVATION IN FEET (NGVD)

220
210
200
190
180
170

AJ AK AL AM AN AO AP AQ AR

LEGEND
500 YEAR FLOOD
100 YEAR FLOOD
50 YEAR FLOOD
10 YEAR FLOOD
STREAM BED
A CROSS SECTION LOCATION

5.2 5.4 5.6 5.8 6.0 6.2 6.4 6.6 6.8 7.0 7.2 7.4 7.6 7.8

STREAM DISTANCE IN MILES ABOVE CORPORATE LIMITS

FLOOD PROFILES

NASHUA RIVER

FEDERAL EMERGENCY MANAGEMENT AGENCY
Federal Insurance Administration

TOWN OF PEPPERELL, MA
(MIDDLESEX CO.)

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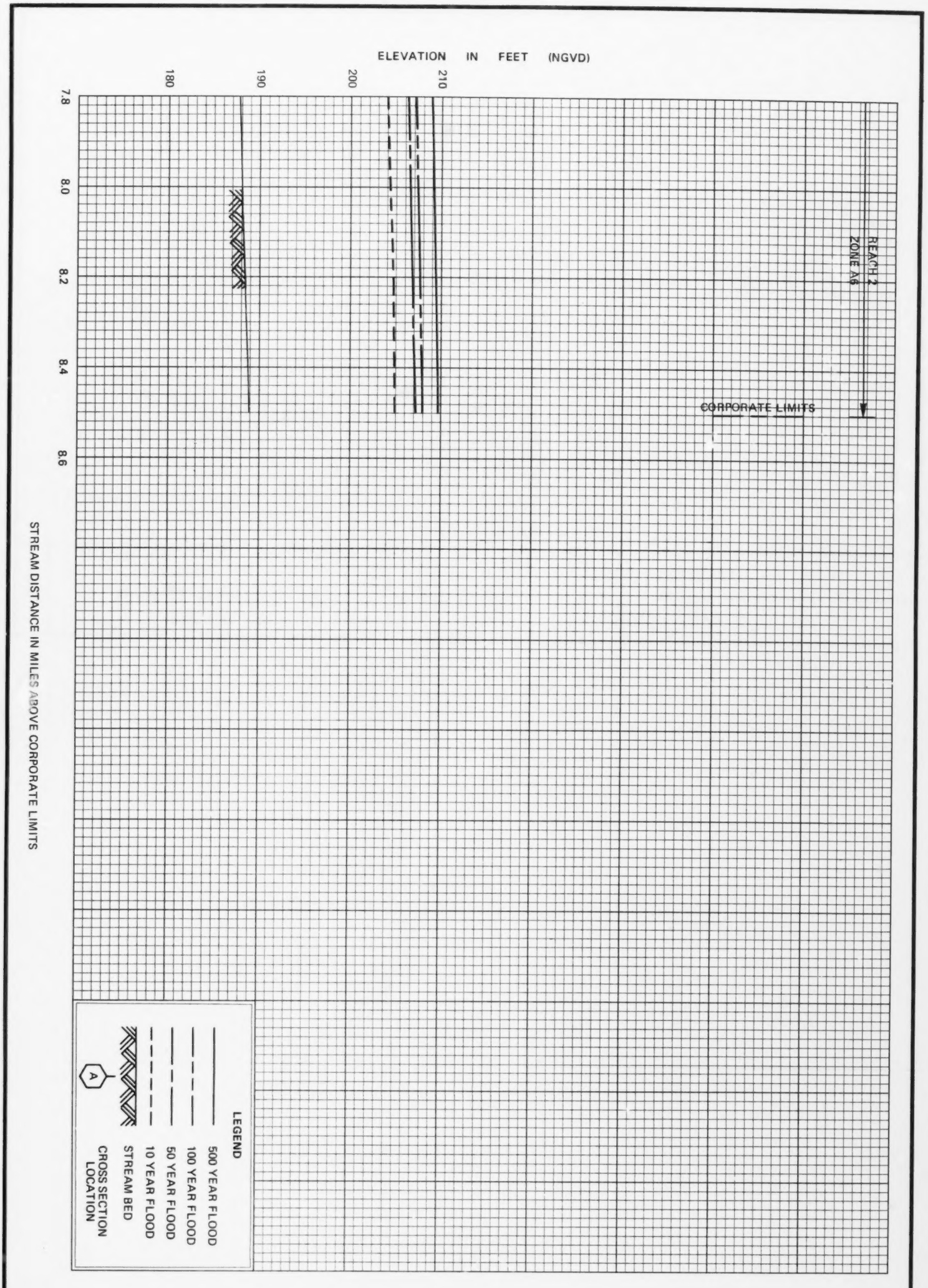

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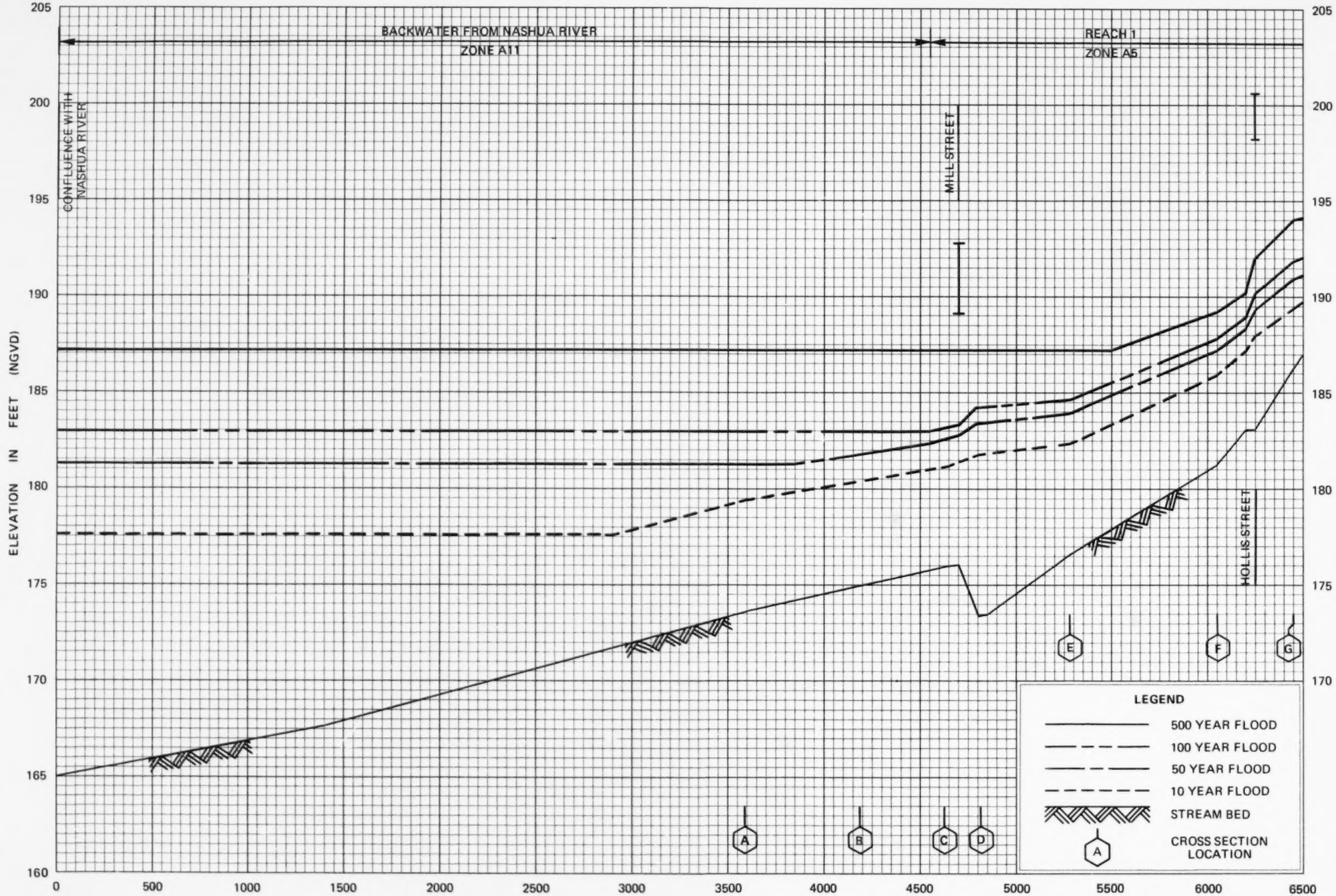
FLOOD PROFILES

NASHUA RIVER



FLOOD PROFILES

NISSITISSIT RIVER

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TOWN OF PEPPERELL, MA
(MIDDLESEX CO.)

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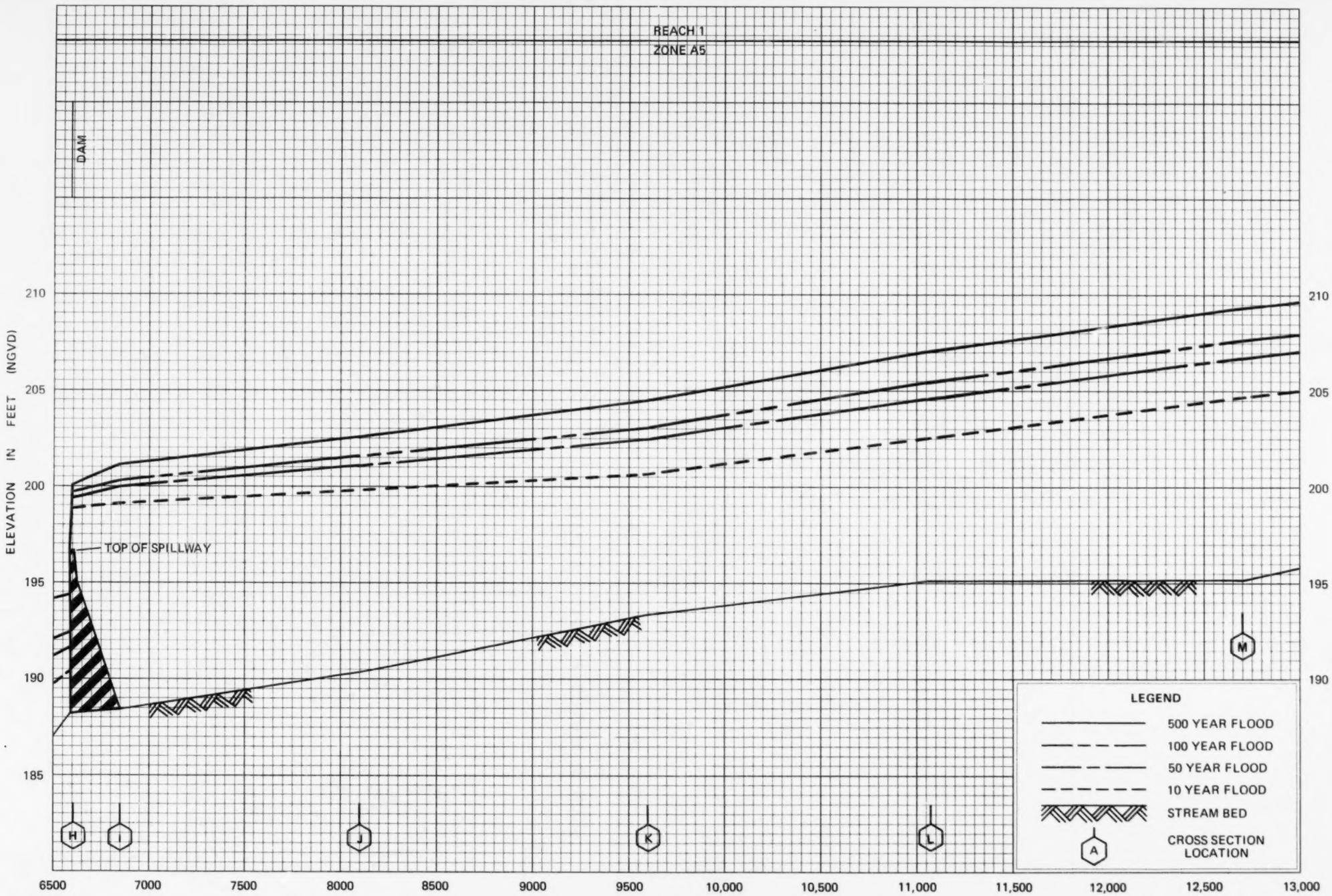

FLOOD PROFILES

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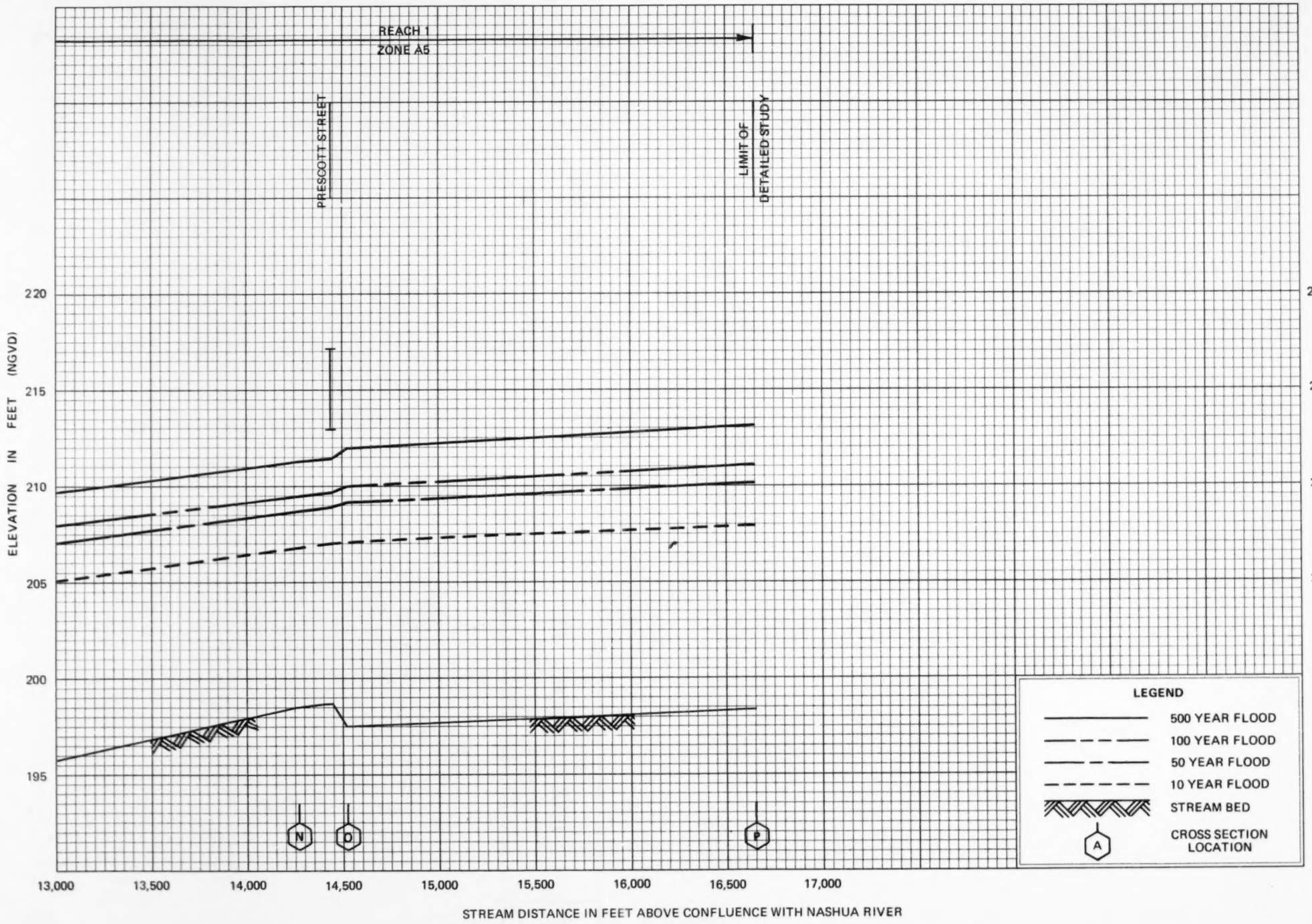

FLOOD PROFILES

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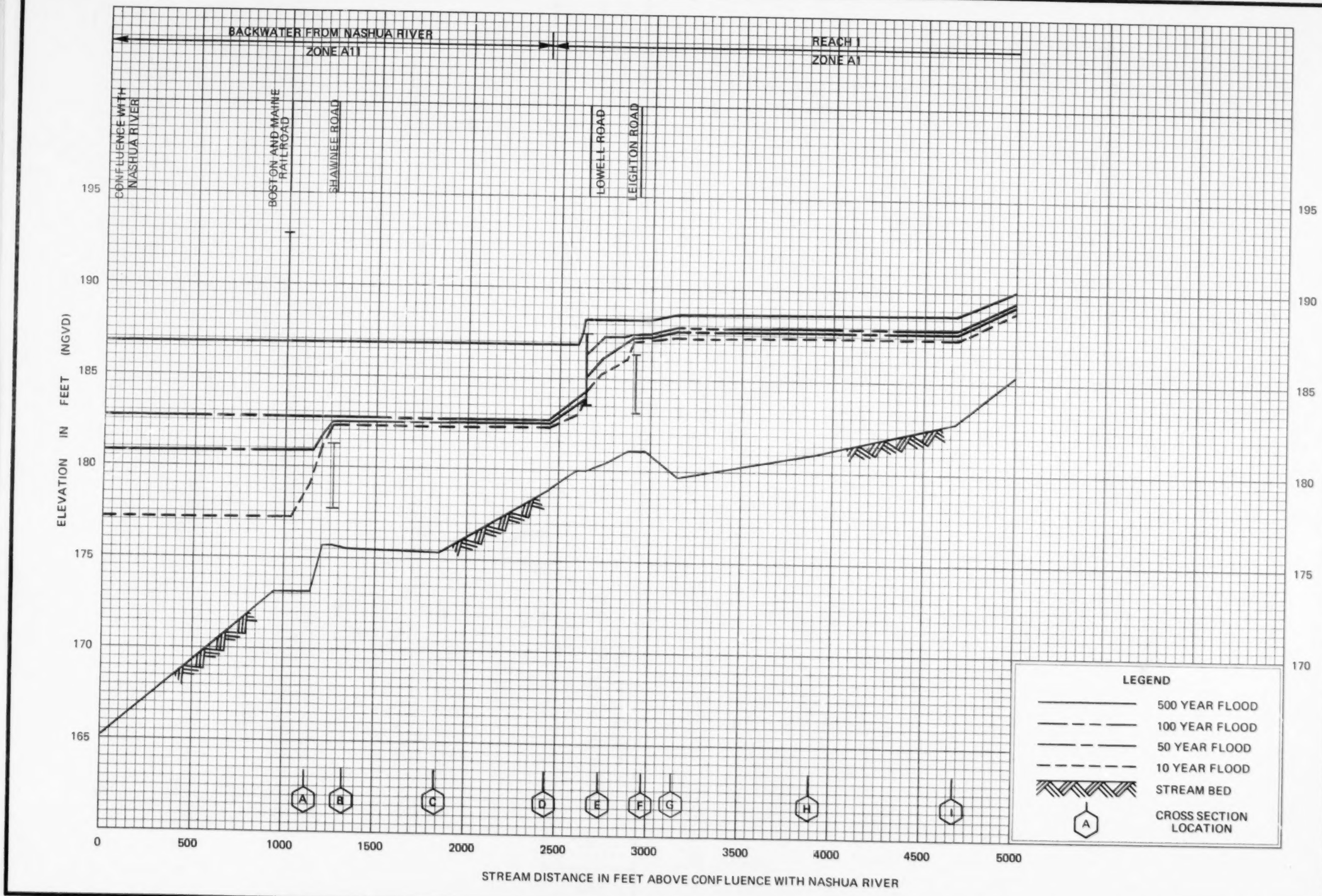

FLOOD PROFILES

REEDY MEADOW BROOK

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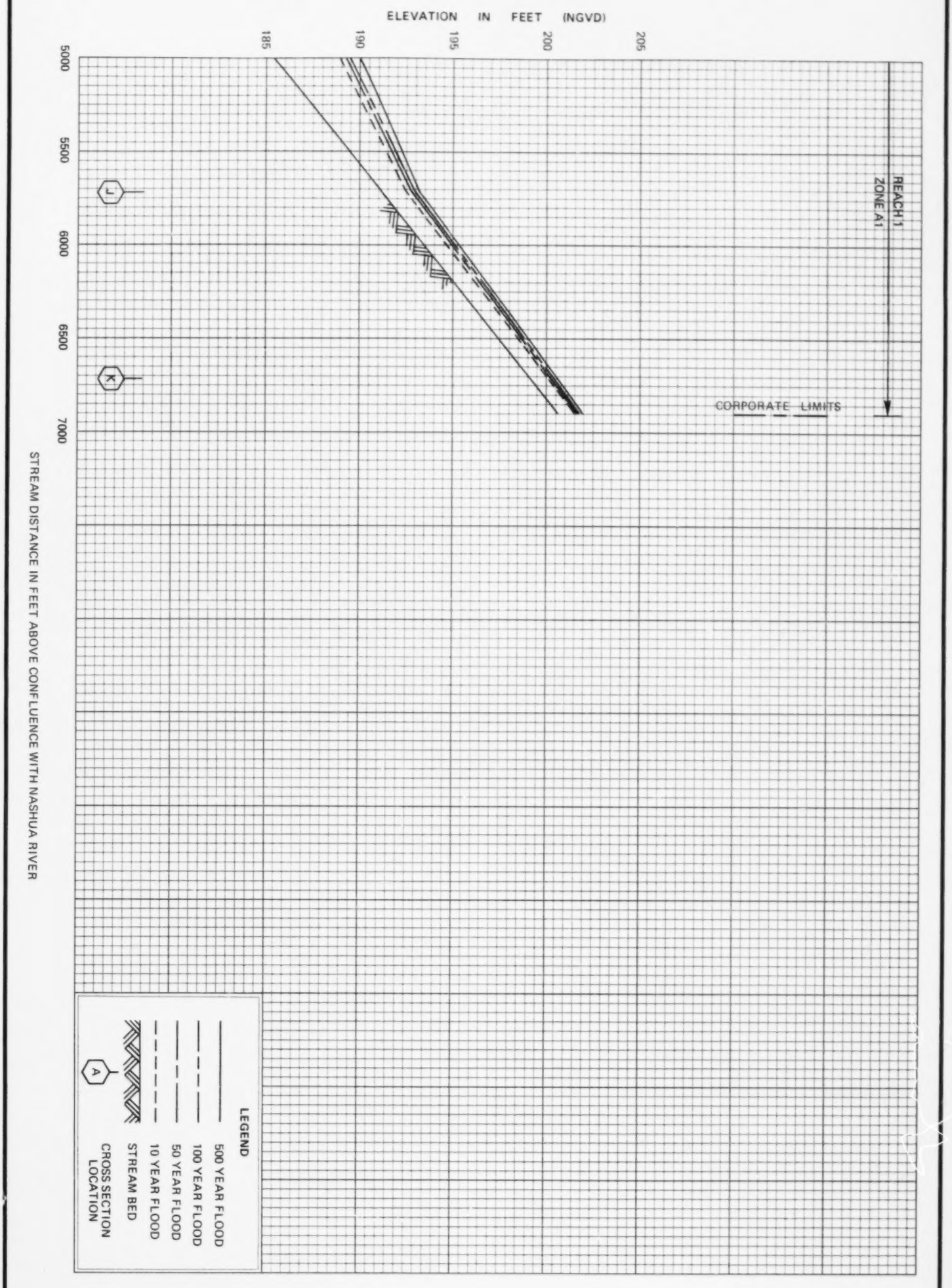

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